Mass Asymmetric Fission Barriers for light Compound Nuclei ($A < 100$)

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Mass asymmetric fission barriers have been calculated with the Rotating Finite-Range Model (RFRM) and the Rotating Liquid Drop Model (RLDM). For very heavy nuclei, the two models give similar values, but as A decreases, the difference in the predictions increase. The experimental study of the fission barriers of light nuclei ($A < 100$) is desirable, since in this mass region the mass asymmetric barriers for the RFRM and RLDM models differ by up to 10 MeV.

Complex fragment emission has been studied for ^{90,94,98}Mo ($4 < Z < 26$), ^{75}Br ($4 < Z < 27$) and ^{70,76}Se ($4 < Z < 21$) [1,2,3]. Six nearly complete sets of mass asymmetric fission barriers have been extracted by fitting measured excitation functions with a transition state formalism. The experimental mass-asymmetric fission barriers corrected for shell effects are compared to the theoretical calculations in Fig. 1. The experimental data are several MeV higher on average than predicted by the RFRM and substantially lower than predicted by the RLDM. These results may suggest the need for refinements of both the RFRM constants and the RLDM constants, if not modifications of the models themselves.

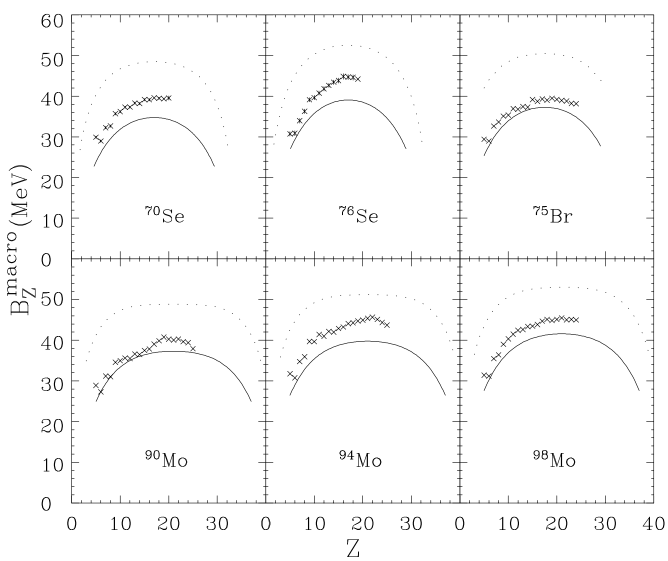

FIG. 1. Experimental mass-asymmetric barriers (symbols) corrected for shell effects compared to the macroscopic model calculations. The dotted and solid curves indicate the RLDM and RFRM predicted values, respectively.

In a recently developed Thomas-Fermi Model (TFM), the so-called congruence energy related to nuclear shape is identified. For the fission process of the intermediate mass nuclei, the congruence energy at the saddle point can be nearly doubled and the fission barriers will correspondingly decrease by several MeV, compared to the case in which the congruence energy of the saddle is assumed to be the same as that of the ground state. To determine if measured data provide evidence for the near-doubling of the congruence energy, in Fig. 2, the measured mass symmetric fission barriers are compared to the TFM calculations for all the six systems, where the fissility parameter is defined as $Z^2/A(1-2.2I^2)$ and $I = (N-Z)/A$. The measured symmetric fission barriers lie somewhat below but closer to Thomas-Fermi barriers which include the shape-dependent congruence energy. This comparison supports qualitatively Myers and Swiatecki's argument for the congruence energy, but a quantitative discrepancy remains. This discrepancy would be reduced by 1 - 2 MeV if account was taken of quantal barrier penetrability in the fission process. Additional measurements are needed to resolve the discrepancies with the model predictions.

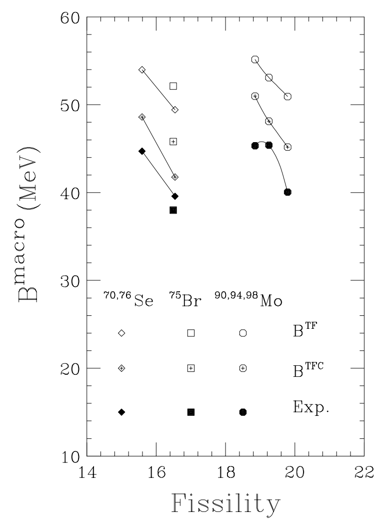

FIG. 2. Measured symmetric fission barriers (filled symbols) corrected for ground-state shell effects and calculations. The open symbols assume that the congruence energy at the saddle is the same as in the ground state (B^{TF}) or is increased because of its dependence on shape (B^{TFC}).

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